Challenges of Rapid Technological Change

Catching up with The JETSONS

Technological change has always been with us...

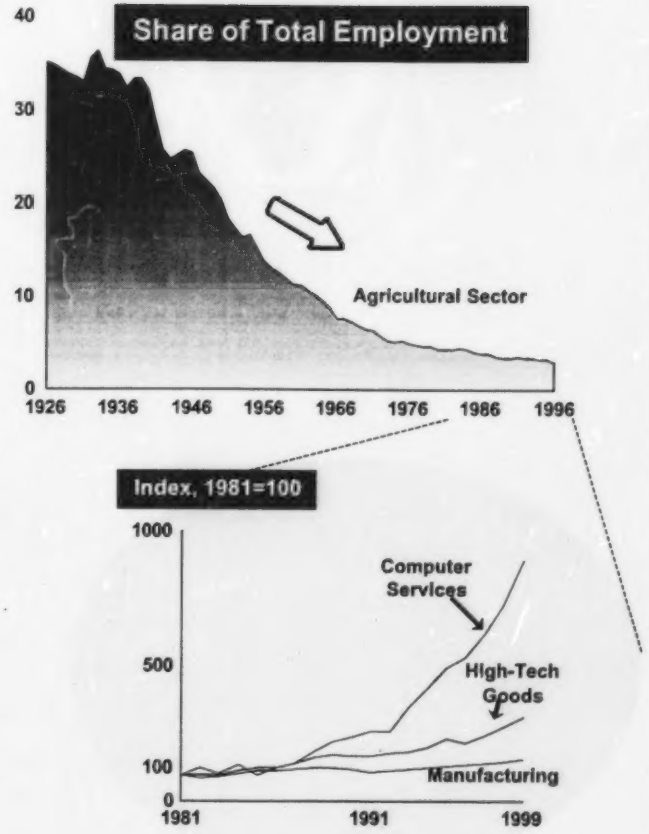
Technological change is continually impacting and reshaping our economy.

At the start of this century, agriculture contributed a large share of our economy.

Since then, manufacturing and then services grew in relative prominence — sparked by new technologies which permit more efficient ways of producing new or better products and services.

More recently, high-tech services and goods are eclipsing other industries in terms of growth.

Technological advance is transforming the Canadian economy, and changing the very basis of our livelihood.

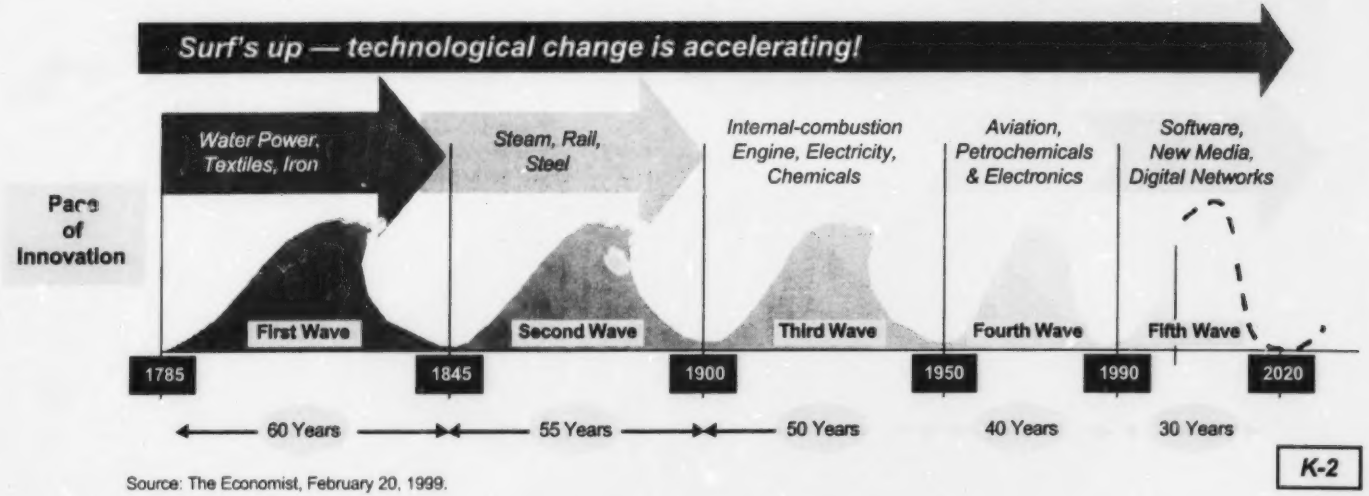


1) Manufacturing does not include high-tech goods
2) High-tech goods include pharmaceuticals, communications & elec. equip., and computers
Source: Statistics Canada

...but <u>now</u> is extremely rapid

Technological advances are now altering our economy at an unprecedented pace.

It's a new business world, where everything is changing. More than ever, business must react quickly to seize the opportunities resulting from change.



Source: The Economist, February 20, 1999.

K-2

Impacting even "traditional" industries

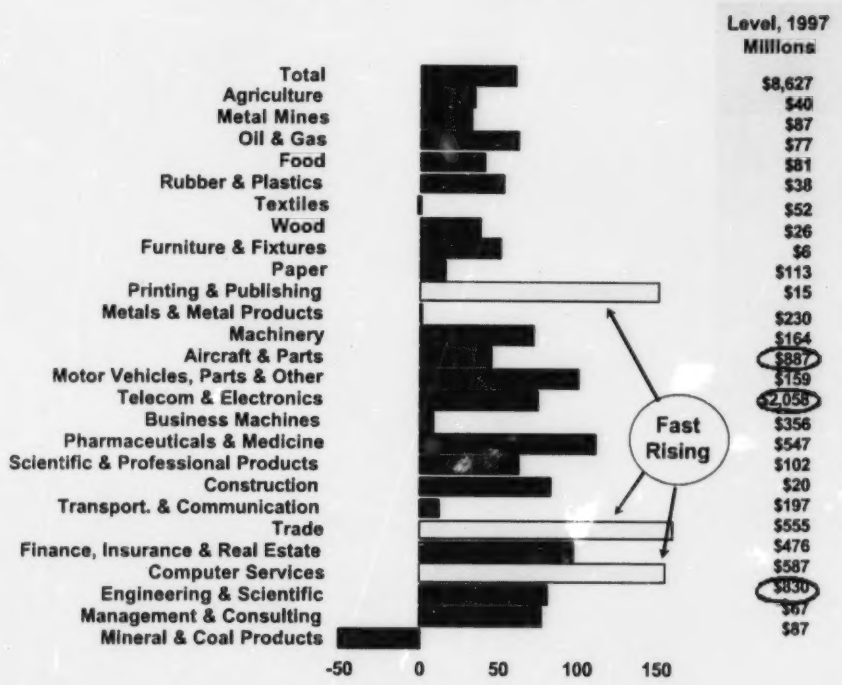
In fact, virtually <u>all</u> industries are undergoing major changes in technologies.

This is contributing to improvements in product quality, and in the increased versatility and flexibility of our industries.

Technological change is embraced even by Canada's traditionally strong resource sector. In fact, resource extraction is becoming quite knowledge-intensive.

Even Mature Industries Are Becoming More Knowledge-Intensive

Growth in R&D Spending, %, 1991-97



Note: These are actual R&D expenditures, not preliminary estimates or intentions.
Source: Statistics Canada, Industrial Research & Development, 1997 Intentions

Innovation is now key to future prosperity

As we move to a more knowledge-based global economy (KBE), comparative advantage relies less on natural resources and more on what we can do with those resources.

Canada's future prosperity depends on rapid innovation, and on winning races to foster new and better products and services.

Competitors in other countries are pressing Canadian industries and companies to step-up their pace of innovation.

To take advantage of rapid technological change, you have to be quick — speed wins!

There are special challenges being next door to the world's foremost KBE

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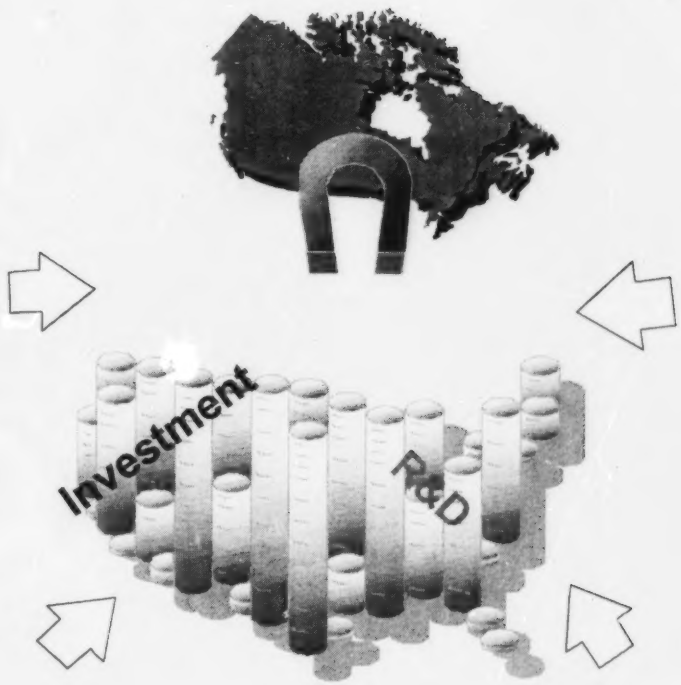
In these races, we find ourselves competing with our neighbour, the U.S. — a clear worldwide technology leader and premier KBE, home to the world's richest pools of R&D and investment.

This sometimes makes more challenging our task to pursue/attract :

- **emerging opportunities;**
- **investment; and**
- **high-knowledge activities.**



But what are the key characteristics of technological change? And how is the U.S. doing better? ...

Dimensions of Technological Change

We are seeing unparalleled increases in innovation...

The impact of technological change is highlighted by the fact that industries generally are becoming more innovative.

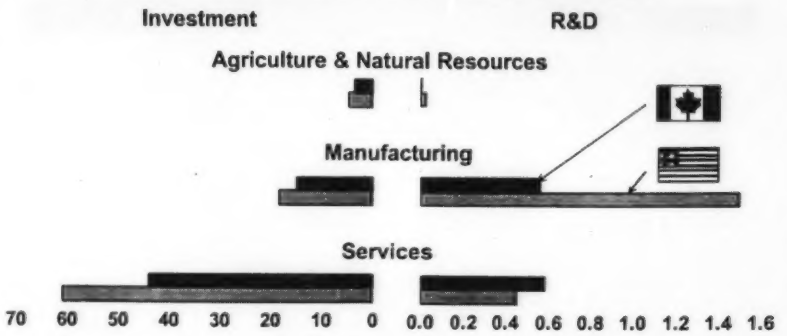
This trend is reflected in higher investment, especially in R&D.

But our overall investment and R&D rates remain low relative to those in the U.S.

- Canadian companies (especially SMEs) are slower than their U.S. counterparts at adopting leading-edge methods and processes.

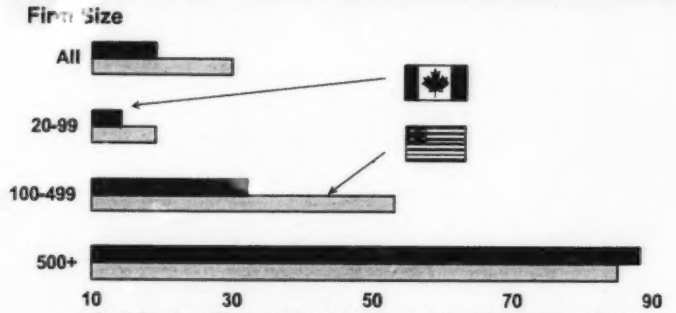
Overall, Canadian companies are about half as likely to be technologically advanced as their U.S. counterparts.

Industries Becoming More Innovative



Investment: Ratio of Investment Stock to GDP, 1996; R&D: R&D spending as % of GDP, 1997.
Source: Industry Canada compilations based on OECD data

Technology Adoption in Canada and the U.S.



% Adopting Five or More Advanced Technologies, 1993

Source: Baldwin and Sabourin (1995), "Technological Adaptation in Canadian Manufacturing (Statistics Canada)

...but the U.S. economy remains more innovative

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And we see greater inventiveness ...

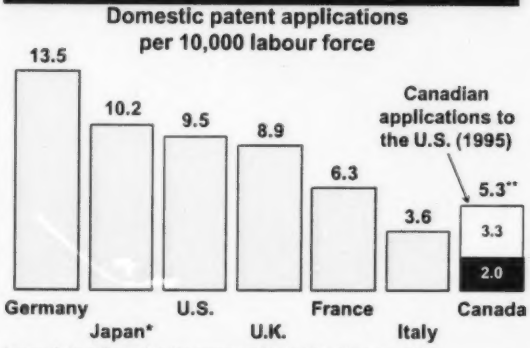
Patenting activity in most industrial countries is growing faster than ever before.

And Canada's propensity to file for <u>domestic</u> patents is growing very fast — first in the G-7.

However, Canada's relative propensity is still low in absolute terms, relative to other countries — even after including patents in the U.S.

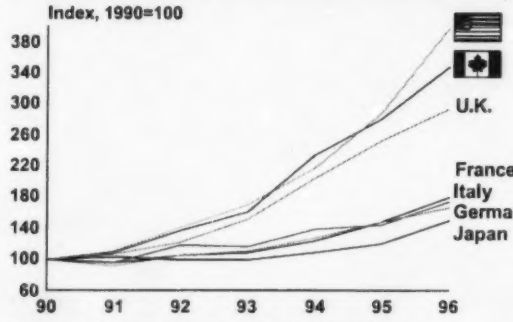
In recent years, there has been a fast rise in <u>foreign-bound</u> patenting in Canada. Canada's growth in foreign-bound patenting ranks second only to the U.S. among the G-7.

Inventiveness Coefficient, 1996



* Japan data adjusted to be comparable to the other countries.
** This is an overestimate of Canada's inventiveness because patent applications may be filed on the same inventions in both countries.
Source: Industry Canada compilations based on OECD data

Growth in Foreign-Bound Patenting



	Applications 1996
	1,175,107
	65,651
U.K.	235,862
France	120,043
Italy	52,033
Germany	261,444
Japan	193,451

Source: OECD Main Science & Technology Indicators

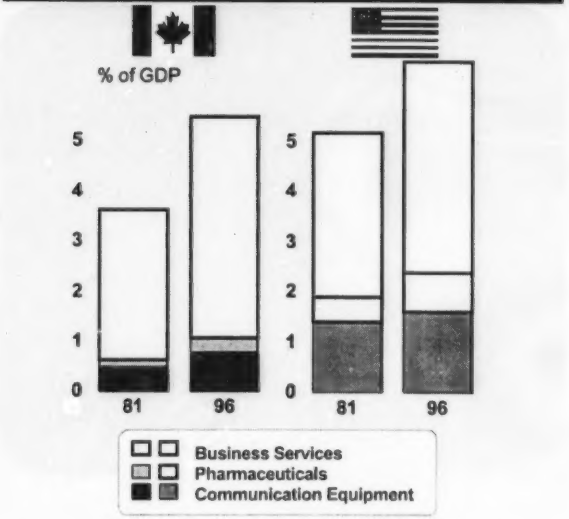
... but the U.S. economy remains more inventive

There is rapid growth in high-knowledge activities...

High-knowledge/tech activities are growing quickly and are playing a greater role in our economy.

However, in the U.S. they comprise a larger share of the economy and are expanding at a faster rate.

High-Tech Share of Total Economy



Source: Industry Canada compilations based on Statistics Canada and US Census Bureau data.

Business Services

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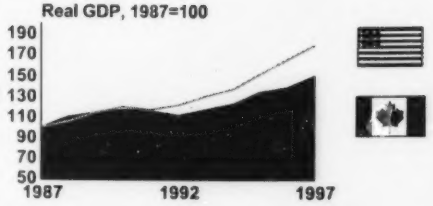
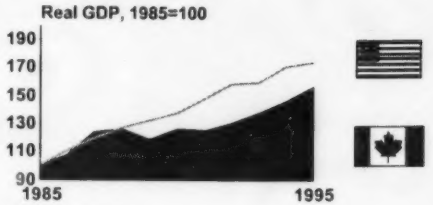
includes software and computer services and other professional services



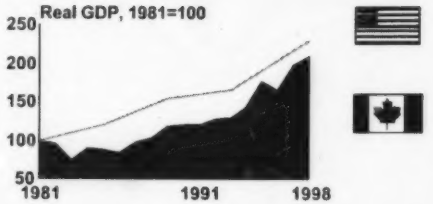
Source: Statistics Canada & US Census Bureau

Pharmaceuticals



Source: OECD

Communications Equipment



Source: OECD

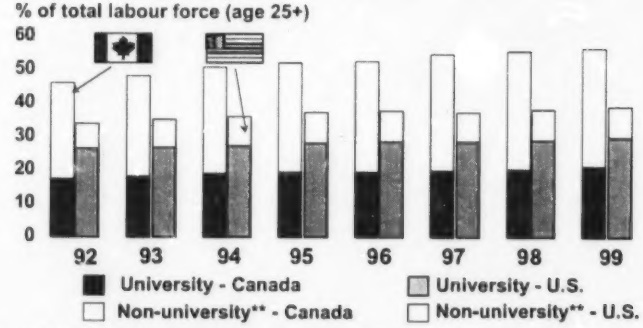
...but U.S. high-tech sectors are larger & more vibrant

Knowledge workers are growing in importance...

As a consequence of technological change, there is also a growing number of workers involved in knowledge discovery and application. Our unprecedented ability to store knowledge and retrieve it rapidly using information technology has shifted the economy's demand toward workers with advanced training or education.

Canada will need more knowledge workers, including professionals such as engineers and architects, as well as college-trained technologists for manufacturing, communications, information technology and other fields.

Post-Secondary Degrees/Diplomas*



* Highest level of post-secondary education attained

** For Canada, this includes certificates from vocational schools, apprenticeship training, community college, CEGEP and occupation-based programs. For the U.S., this includes associates degrees granted by colleges in occupational/vocational and academic programs.

Source: Statistics Canada, U.S. Bureau of Labor Statistics

Facts:

Researchers per 1000 labour force, Canada 1995, U.S. 1997	5.4	8.1
Percentage of 24 year-olds with University Degree		
Male	27.2%	29.3%
Female	37.6%	36.7%
Proportion of 24-year-olds whose 1st University Degree is awarded in S&E		
Among Males	7.3%	6.9%
Among Females	3.6%	3.8%

Source: Statistics Canada, U.S. Bureau of Labor Statistics, U.S. National Science Foundation

...but the U.S. has more university-schooled workers

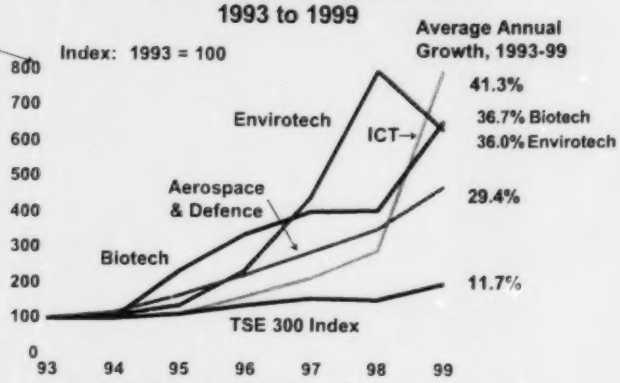
There are many new & emerging industries ...

Technological developments have resulted in a proliferation of new industries.

Many will likely be critical to tomorrow's economic performance and the everyday activity of business.

The growth of high-tech shares traded on the TSE has far exceeded the TSE average, many growing at twice the average rate and Envirotech growing at nearly four times the average rate.

Canadian Market Capitalization*
1993 to 1999



* Based on sectoral portfolios composed of 10-15 Canadian firms.
Source: TSE

Emerging industries —

Growing on average 2½ times total GDP

Employment, 1999*

			U.S. vs. Canada
Biotech	10.4	150.9	14.5 times larger
ICTs	460	4281.2	9.3 times larger
Envirotech	71.9	885.7	12.3 times larger
Aerospace	43.2	547.6	12.7 times larger

* Based on DRI estimates, thousands

...but many of the U.S. industries are proportionately larger

Strong ICT technological infrastructure is paramount...

The U.S. is a clear worldwide technology leader when measured against several traditional and new comparative benchmarks.

Virtually all households in Canada have access to traditional modes of communication such as telephone and basic cable TV.

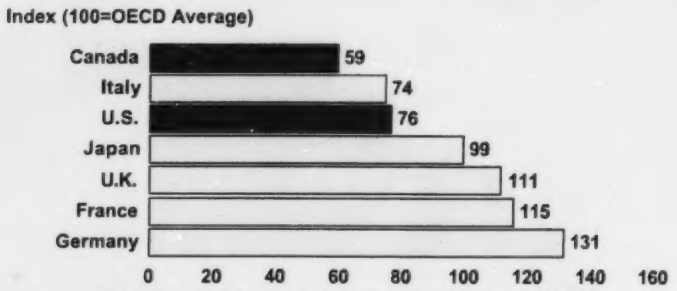
However, Canada has the lowest telephone & Internet access charges in the G7!!

Indicators of ICT Infrastructure

Cell Phone Subscribers per 100, 1997	13.8	20.7
# of Internet Hosts per 1000 inhabitants, 1999	83.0	93.0
Secure Web Servers for E-Commerce per 100,000 Inhabitants, 1998	3.4	6.1

Source: Statistics Canada, Canadian Economic Observer Feb. 1999 and World Telecommunication Development Report 1998

Telephone and Internet Access Charges, 1998



Source: OECD Communications Outlook, 1999. US$, PPP indexed to OECD average. Based on blend of 20 peak and 20 off peak hours online.

...but the U.S. is a leader

And the U.S. is taking better advantage of the Internet...

The Internet economy in Canada, although growing rapidly, still composes a smaller share of overall economic activity than in the U.S.

Based on a 10 to 1 ratio, Canada's Internet economy is only living up to its potential in the area of infrastructure for the Internet economy.

Fact:
Canadians spend on average $291/yr online (US$) while Americans are spending $1326

Source: Calof & Nash., 2000

The Internet Economy: U.S. vs. Canada

	Revenue $Billion		
			U.S. vs. Canada
Infrastructure	22.2	170.6	8 times larger *
Applications	0.8	33.5	100 times larger
e-commerce	5.5	206.3	38 times larger
Total	28.5	414.4	15 times larger

Software development and web development & consulting

	Jobs		
			U.S. vs. Canada
Infrastructure	70,400	473,000	7 times larger *
Applications	7,400	408,000	55 times larger
e-commerce	17,300	762,000	44 times larger
Total	95,100	1,478,000	16 times larger

* Given the relative size of the two economies, an appropriate "ratio" for Canada would be no more than 10 to1.
Source: Information Technology Association of Canada, 2000

...and the Internet economy

The Internet is now a <u>strategic</u> business priority...

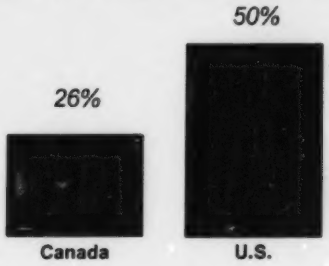
Canadians are spending a lot on merchandise at American sites. Excluding financial transactions and travel-related online purchases, Canadian consumers spent 63% of their online dollars at U.S. Websites in 1999.

- **And only 26% of Canada's 200 largest retailers offered Web-based shopping last year, compared with about 50% of comparable retailers in the U.S.**

The Borderless Nature of the Internet

Canadian spending on-line, 1999

Retailers conducting commerce online, 1999



Source: International Data Corporation, 1999

...but more so in the U.S.

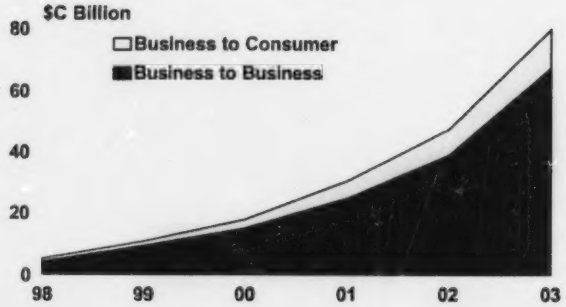
While e-biz is taking off in Canada...

A significant feature of our new global and information-driven environment is the rapid growth in e-commerce — and e-Biz is still just in its infancy.

E-biz will impact on a substantial part of everyday activity, from retail to trading relationships.

E-commerce market and forecast

Canada



* Source: International Data Corporation (1999) and The Boston Consulting Group.

Canada's Internet commerce is expecting rapid growth. Recent forecasts has it jumping to $93.7 billion by 2003, from around $11 billion in 1999.

However, the government is setting a new goal for the year 2003 — for Canada to capture a 5% share of world e-commerce, which would mean doing $200 billion of business in this way.

Source: Boston Consulting Group calculation based on figures in Report of the Canadian E-Business Roundtable, 2000

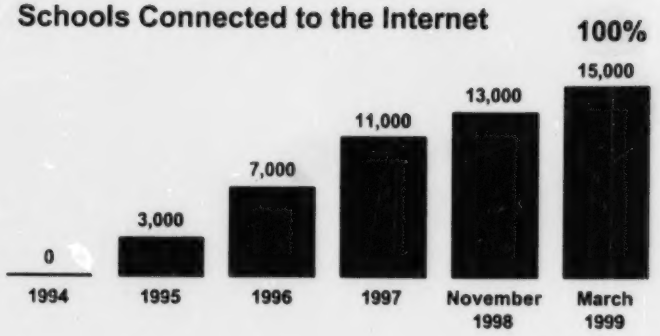
...it is not growing as fast as elsewhere L-10

However, in public "cyberspace", we compare well

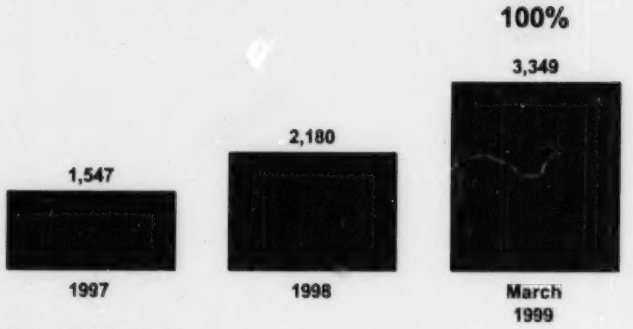
We see the pervasiveness and "quality" of our ICT technological infrastructure increasing dramatically.

By the end of March 1999, virtually all public schools and libraries in Canada were connected to the Internet, and presently there are almost 4,300 community access sites.

Schools Connected to the Internet

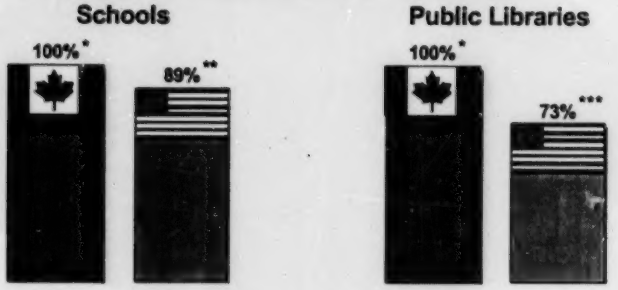


Public Libraries Connected to the Internet



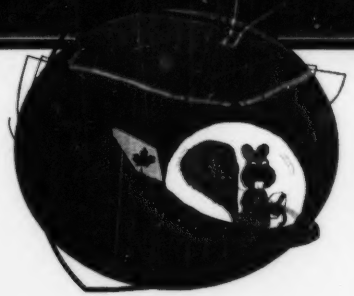
Source: Industry Canada

Percent Connected to the Internet



* March 1999
** Based on Survey in Fall 1998
*** 1998
Source: IHAB, Industry Canada, National Centre for Educational Statistics, U.S. and 1998 National Survey of Public Library Outlet Internet Connectivity, U.S.

Challenges & Prospects



Unprecedented times, unprecedented challenges

Rapid technological change and the ensuing rise in importance of innovation involve <u>many</u> challenges.

For instance, faster innovation requires:

1

- **more capital**
- **abundant new skills and**
- **a greater capacity to create new ideas.**

2 **Canada also needs to "commercialize" more of its ideas.**

3 **Other concerns include the impact of technological change on the commonality of standards and on corporate/industrial restructuring.**

4 **Underscoring all this is the expectation that technological change will pick-up.**

Increased innovation requires more capital...

To take advantage of new knowledge and ideas, it is mandatory that business, and economies generally, undertake more investment:

- **in R&D (new knowledge creation)**
- **in revitalizing / rebuilding plants and equipment that facilitate new technologies and the production of new goods and services.**

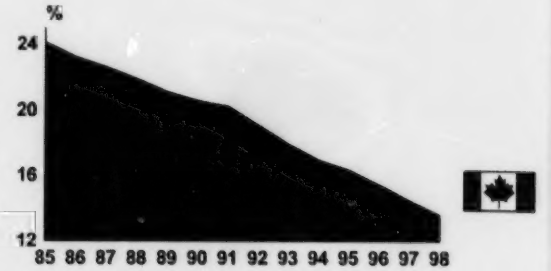
Canadian investment is not keeping pace with that in the U.S., plus we are attracting a smaller share of Northern American FDI, including by U.S. MNEs, who are increasing their investment in the U.S. at a faster clip.

- *More high-tech Canadian companies are going to the U.S. to obtain capital.*

Investment in M&E as Share of GDP

* 1999 data is for first two quarters only
Source: OECD Quarter National Accounts

Canada's Share of North American FDI *



* Includes FDI received by Canada, the U.S. and Mexico from all sources
Source: OECD and UN

...but U.S. business is investing more in innovation

M-2

We need more workers with front-line knowledge...

The efficacy of investment depends on the availability of highly skilled professionals.

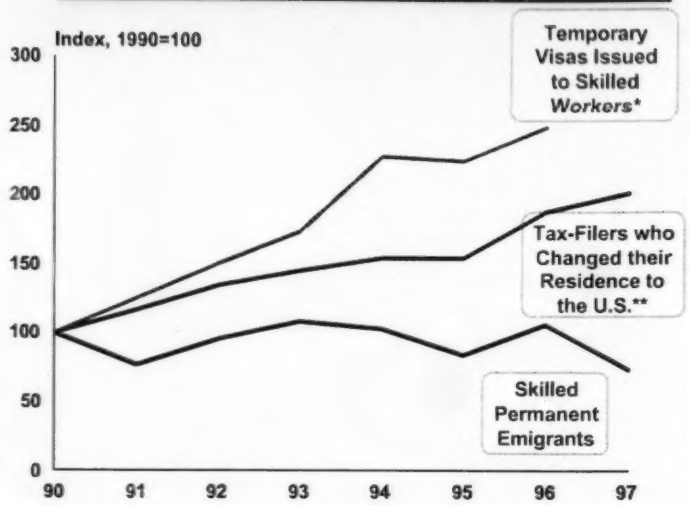
We need to prepare Canadian students for the 21st century. That challenge has never been tougher, given the rate at which established technologies are changing and new ones emerging.

Plus, we need to attract/keep the best — people who are at the "cutting-edge". But we are finding that many of our "best and brightest" are going to the U.S., attracted by better job opportunities, higher incomes, and lower taxes.

Composition of Permanent Emigrants, 1997

	Percent	Number
Executives & Managers	37.5	1,866
Engineers, Computers & Natural Scientists*	18.4	916
Artists & Social Scientists	11.2	555
Nurses	11.0	545
Teachers & Professors	8.2	406
Doctors	8.0	398
Other health occupants	5.8	291

Estimates of the Growth in Emigration to the U.S.



Combining evidence from tax records and temporary visas with permanent immigration data clearly shows a significant rise in highly skilled workers leaving Canada.

* Admissions of temporary workers in professional occupation visa classes (NAFTA (TN), professional worker (H-1B) and intracompany transferees (L))
** Statistics Canada estimated share of total emigrants (50%)
Source: Statistics Canada, U.S. Immigration and Naturalization Service

...but we fear we are losing our 'best & brightest'

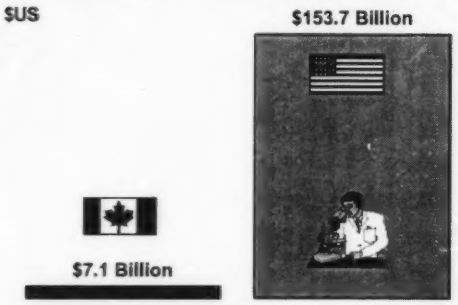
We must carry-out R&D and "create" ideas...

By improving the capacity for R&D, we support the source of the new ideas that will lead to new activities and more value-added products and services — that in turn contribute to more high-skill employment and overall prosperity.

We must become, to a greater degree, creators in our own right.

Right now, our R&D remains considerably below that of the U.S. and many other industrialized countries.

Business Expenditures on R&D, 1997

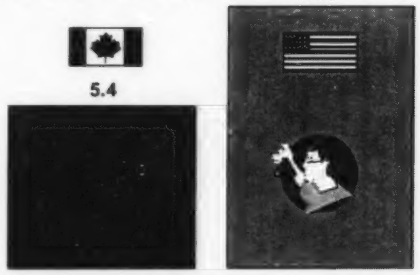


Business Expenditure on R&D, % of GDP

	1981	1985	1990	1996
Canada	0.6	0.8	0.8	1.0
U.S.	1.7	2.1	2.0	1.9

Researchers per 1,000 Labour Force

1995 for Canada and 1997 for the U.S.



Source: OECD and U.S. National Science Foundation

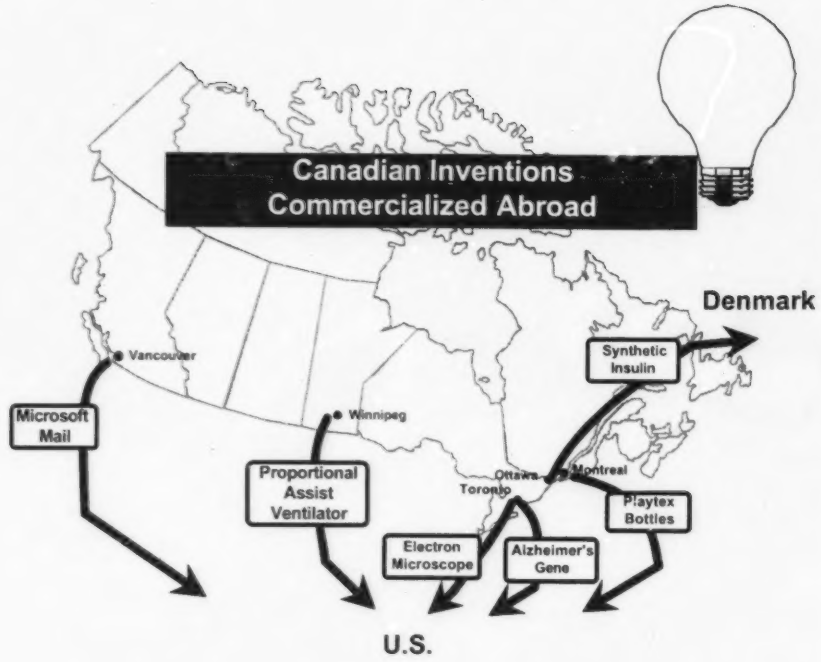
...but the U.S. businesses spends much more on R&D

Just as important, is "commercializing" ideas...

It's not just the creation of ideas and knowledge that is important, but their diffusion and commercialization.

New developments at the interface of commerce and science raise important issues:

- **e.g. in the area of regulations/standards and liabilities, and facilitating regulatory and framework policies.**



...but we fail to reap the benefits of our inventions

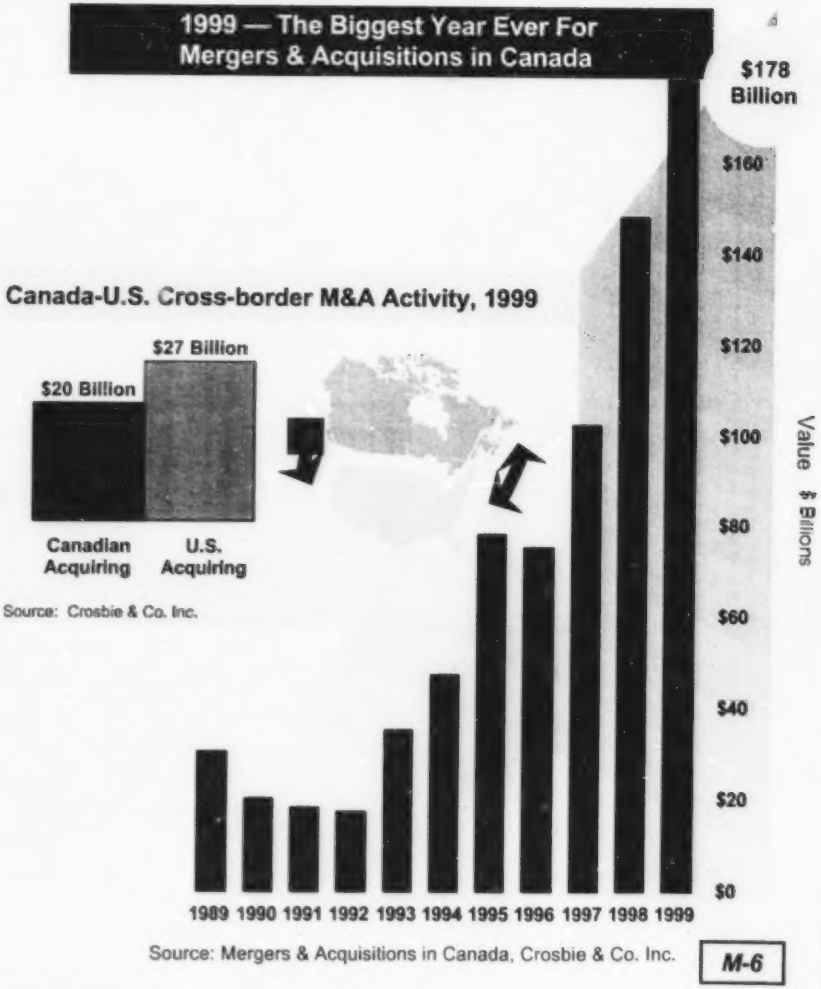
Tech-change is abetting industrial and corporate restructuring

Technological change, alongside globalization, is facilitating corporate restructuring and merger and acquisition (M&A) activity. New technologies permit the rapid transfer of critical information, enabling companies to invest in a wide range of ventures in the U.S. and around the world. Many mergers involve companies seeking greater pricing power and economies of scale in their increasing globalized markets.

Recently announced M&As involving large Canadian companies include:

CN Railway - Burlington Northern $28.0 billion*	Canada - U.S.
British American Tobacco - Imasco $10.5 billion*	U.K. - Canada
Uniphase - JDS Fitel $8.9 billion	U.S. - Canada
Nortel Networks - Qtera $4.8 billion*	Canada - U.S.
Weyerhaeuser - MacMillan Bloedel $3.6 billion*	U.S. - Canada
Quebecor Printing - World Color Press $2.2 billion	Canada - U.S.

* Announced M&As — not necessarily completed
Source: Crosbie & Co. Inc.



Source: Mergers & Acquisitions in Canada, Crosbie & Co. Inc.

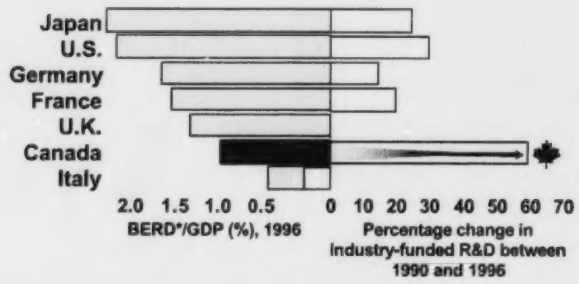
How are we Responding & Preparing for the Future?

Business is responding...

Canada's future success hinges on the ability to take advantage of new opportunities associated with the KBE and to meet the challenges of technological change.

This requires "developing" our current comparative advantages and creating new competitive advantages — based on innovation.

Industry Research and Development

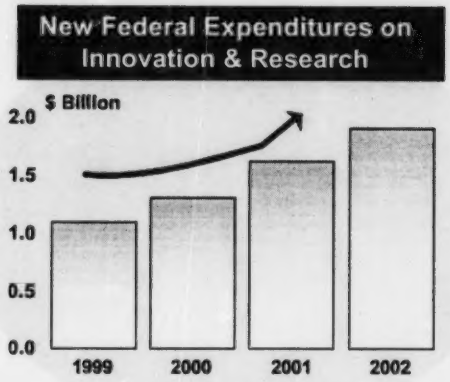


* Business Expenditure on Research and Development
Source: OECD

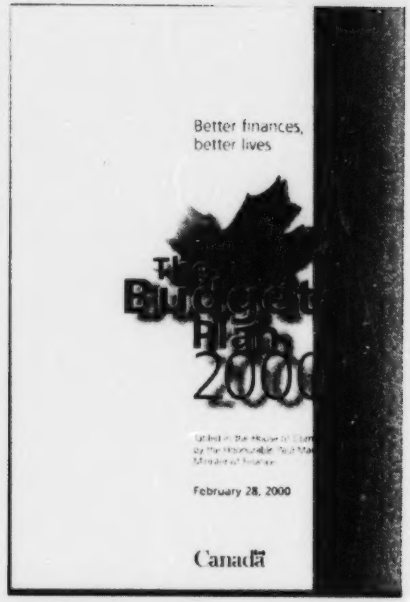
While our businesses lag in their spending on R&D, they are taking steps to invest more in R&D and technological adoption and developing new comparative advantages.

...and government is also answering the call

Making Canada's economy more innovative was a major theme of the 2000 budget.



Source: Statistics Canada



The 2000 federal budget allocated an additional $1.9 billion in spending over the next four years to promote R&D and innovation in Canada.

Canada has an Innovation Strategy

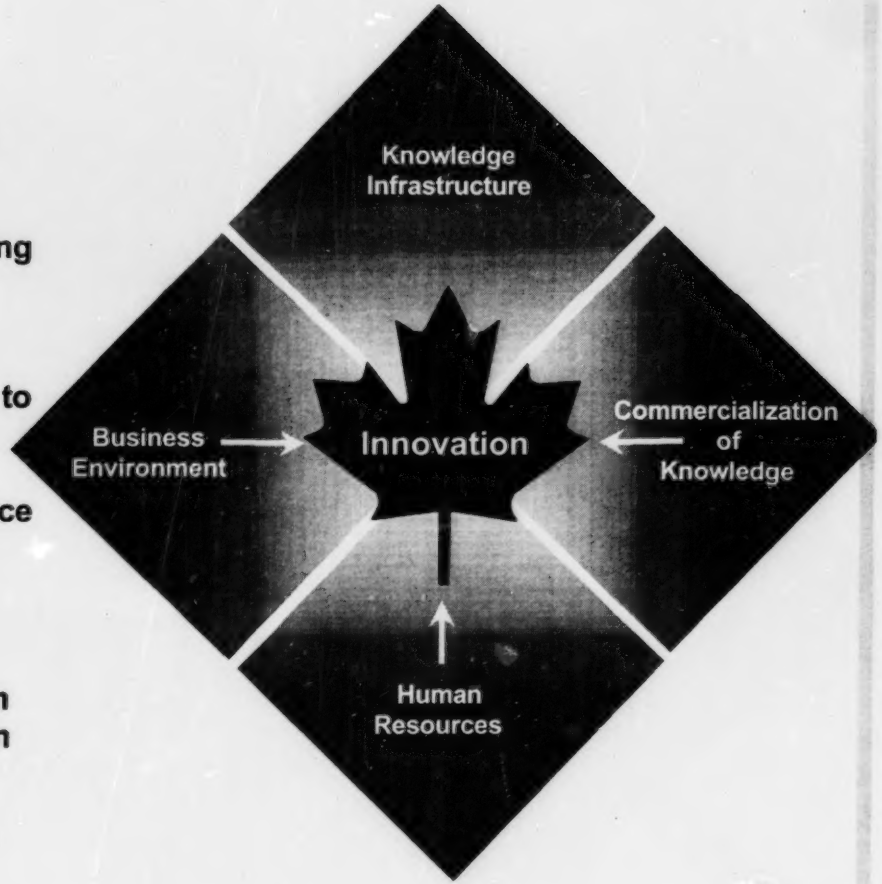
Canada's innovation Strategy addresses:

Knowledge infrastructure — to ensure Canadians are at the forefront of generating new ideas;

Commercialization — to facilitate the necessary partnerships and mechanisms to capture the benefits of new ideas

Human resources — to develop a workforce with the skills and attitudes to make new things happen, and

Business environment — to modernize marketplace policies to keep the Canadian investment climate conducive to growth in the global knowledge-based economy.



Outlook — more and possibly faster technological change

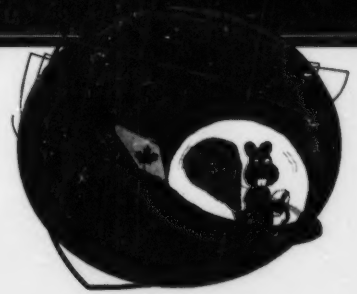
Over the next decade, most authorities believe technological change will only speed up. Countries whose innovative capacity is developing at a faster clip will be in the best position to take advantage.

Ultimately, all countries are becoming more innovative. Just to "keep pace", countries need to actively focus on adopting and embracing technological change.

Innovative capacity is developing at a faster clip in the U.S. and many other countries.

Michael Porter suggests both Canada and the U.S. must continually improve their innovative performance, or else slip in relative ranking — with dire consequences for the future.

Some Key Messages



Some key messages

Today's technological change is unprecedented — in how it impacts and shapes our economies.

To take advantage of technological change it's paramount we be innovative, whether it be in the business, government or university sectors. This means doing a better job:

- **encouraging investment**
- **building and promoting a knowledge workforce**
- **creating, developing and commercializing ideas.**

It also means pursuing emerging opportunities and the high-knowledge activities required of an innovative economy.

In this quest, we frequently find ourselves competing with our neighbour, the U.S. — a clear worldwide technology leader and premier KBE, and a benchmark to mark our future success.

By doing the right things now, Canada won't be left behind in the 21st century. Rather, we will be able to make our way into the new millennium as a more prosperous country, with good jobs and a globally competitive, KBE.

For Further Information

We welcome your questions, comments and suggestions? You can reach us by ...

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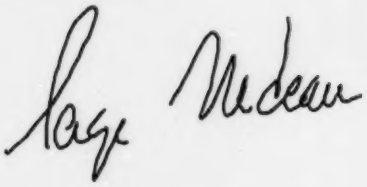
The *Micro-Economic Monitor* is prepared on a quarterly basis by the Micro-Economic Analysis Directorate of Industry Canada. The Monitor provides a quick and easy-to-read update on Canada's economic performance. It also provides topical in-depth reports on current economic issues from a micro-economic perspective.

The current analysis update was prepared by Marianne Blais, Julie Dubois, Joseph Macaluso, Alison McDermott, and Karen Smith, under the direction of Shane Williamson.

This quarter's feature was prepared with the assistance of Gary Sawchuk from Strategic Initiatives and Aaron Sydor and Nigel Marshman from the Strategic Investment Analysis Directorate. Presentation / data assistance was provided by Caroline Farmer and Danielle Lépine, and translation by Lucie Larocque. Gary Sawchuk is the General Editor of Special Features in the Micro-Economic Monitor.



ISSN 1206-260X